Estimation of levels and trends in age at first sex from surveys using survival analysis

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Estimation of levels and trends in age at first sex from surveys using survival analysis

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Age at first sex is an important indicator of exposure to the risk of pregnancy and risk of sexually transmitted infections, including HIV, during adolescence. In fertility studies age at first marriage is often used as a proxy measure of the onset of a woman's exposure to pregnancy, but in many societies premarital sexual activity is common, and it has been proposed to use age at first sex as a better proxy (Stover 1998). In the context of the AIDS epidemic, accurate monitoring of trends in age at first sex has become even more important. Interventions target youth and promote postponement of first sex or discourage premarital sexual activity. In several countries, trends in HIV prevalence among pregnant women attending antenatal clinics have shown a decline in the younger age groups, while older women do not show such changes (Bunnell et al. 1999,Kilian et al. 1999). Such changes may be associated with changes in age at first sex, rates of partner change, sexual mixing patterns, and condom use. In Uganda, a rapid increase in age at first sex in urban areas between 1990 and 1995 was considered a major contributing factor in the observed HIV prevalence decline in young pregnant women from about 1993 (Asiimwe Okiror et al. 1997).

Various indicators have been used to measure age at first sex from cross-sectional data in a single survey and to assess change over time from data in multiple surveys, but existing data have not been fully utilized. This paper describes how survival analysis can be used to estimate age at first sex among adolescents. The method facilitates assessment of trends, and can also be used to assess the consistency and quality of reporting between surveys. The method is illustrated with the application to data reported by women in six countries in sub-Saharan Africa with multiple cross-sectional surveys during the past ten years.

Current practices

In cross-sectional surveys that focus on reproductive and sexual health, ever-married respondents are usually assumed to have initiated sexual intercourse, and are asked to recall at what age they first had sex (recall data). Unmarried respondents 15 years and older are asked whether or not they have ever had sex (current status data) and, if so, how old they were when they first had sex (recall data). These questions are used in the Demographic and Health Surveys (DHS), in AIDS knowledge attitude and practices (KAP) surveys (e.g. (Ferry and Cleland 1996)), and more recently, in adolescent sexual health surveys. Based on these questions a wide range of measures have been used to describe the onset of sexual activity among adolescents in populations. Table 1 shows a sample of such measures with selected advantages and disadvantages of each measure.

Calculation of the median age at first sex can be based on recall or current status data. DHS country reports present the median age among respondents in five-year age groups, based on retrospective reporting. In many surveys fewer than 50% of all respondents 15-19 have ever had sex and no median age at first sex is presented in DHS reports for this age group. The population median is a more useful measure than the population mean, as calculation of the

latter requires that all persons should have initiated sex. The mean based on those teenagers who have started to have sex is invariably biased downward and generally this problem is given insufficient attention in studies using this measure.

Table 1
Summary measures of age at first sex used in selected studies.

Measure	Type of data	Examples	Comments
Percent ever had sex among 15-19	Current status	(Singh et al. 2000)	Sensitive to shifts in age composition within 15-19 age group; does not use recall data to reduce sampling error
Percent ever had sex among never married 15-19	Current status	(Singh et al. 2000)	Sampling error increased by never-married restriction; trend analysis can not distinguish between change in age at first sex and age at first marriage
Percent ever had sex in two or three year age groups (e.g. 15-17, 18-19)	Current status	(Blanc & Rutenberg 1991; Meekers & Ahmed 2000)	Sampling error increased by use of narrower age groups; does not use recall data to reduce sampling error
Median age at first sex among 15-19, smoothed using running average	Current status	(Asiimwe Okiror et al. 1997)	Irregularities in single year current status data are smoothed by taking three year average; does not use recall data to reduce sampling error
Median age at first sex among 15-19 and 20-24	Recall	DHS survey reports	Not reported for 15-19 if less than 50% overall have initiated sexual intercourse even if current status data indicate that median age is under 20
Percent had sex by age 18 among 20-24	Recall	(Blanc & Way 1998)	Compared with older cohorts (e.g. 40-44) to assess trends and percent married by age 18, does not use current status data for 18-year olds
Mean age at first sex	Recall	(Agyei et al. 2000; Gorgen et al. 1998; Rwenge 2000)	Frequently used in adolescent survey reports; mean can only be computed for those who have initiated sex; often misleadingly presented even if not all adolescents have ever had sex

Current status data can be used to describe the pattern of age at first sex expressed as the proportion of women who ever had sex by any single year of age. Another simple summary measure is the proportion of males and females aged 15-19 who have ever had sexual intercourse (Singh et al. 2000). The median age at first sex can be obtained by interpolation among the proportion ever sexually active by single years of age, provided more than 50% had

sex before age 20. Allowance should be made for the fact that the reported age in years is half a year younger on average than the actual age, since what is reported is age at last birthday.

The advantage of using only current status data is that they are based on a single, simple yes/no question. Problems with the current status methods are related to sample size, reporting bias and age misstatement. Single year age groups are relatively small, even if the total number of survey respondents is large, and sampling error may be large. This may have considerable impact on estimation of the median. Some analyses have used three-year moving averages to smooth the curve (Asiimwe Okiror et al. 1997), in others larger age groups have been used: 15-17, 18-19, etc., (Gage Brandon and Meekers 1992), but these are only partially satisfactory approaches. Also, construction of a life table based on current status data linked over a wide range of ages implies an assumption about homogeneity of behaviour across the age range, which may be inappropriate in times of rapid change.

Survival analysis

The most appropriate method for estimating median age at first sex from censored observations is survival analysis (Davis and Lay Yee 1999). Maximum likelihood estimation methods have also been used, but these are more cumbersome (Wielandt and Boldsen 1989) and require assumptions about the underlying parametric form of the distribution. The input data for survival analyses are age of the respondent, whether or not they have ever had sex and, if applicable, recalled age at first sex. Age at the time of interview and current status data from those who have not yet started as well as recalled age at first sex among those who have started are used in a life table analysis to obtain the virginity survival function by age. Those who never had intercourse are considered censored at their current age and reported age at first sex is the failure event. It is a straightforward calculation to estimate person years of exposure at each single year of age, and to calculate the life table cumulative risk function q_x for becoming sexually active, and from this, the proportion still virgin, l_x at any age, allowing for censoring effects. Most of the standard statistical analysis packages provide routines for generating and comparing the resulting life tables.

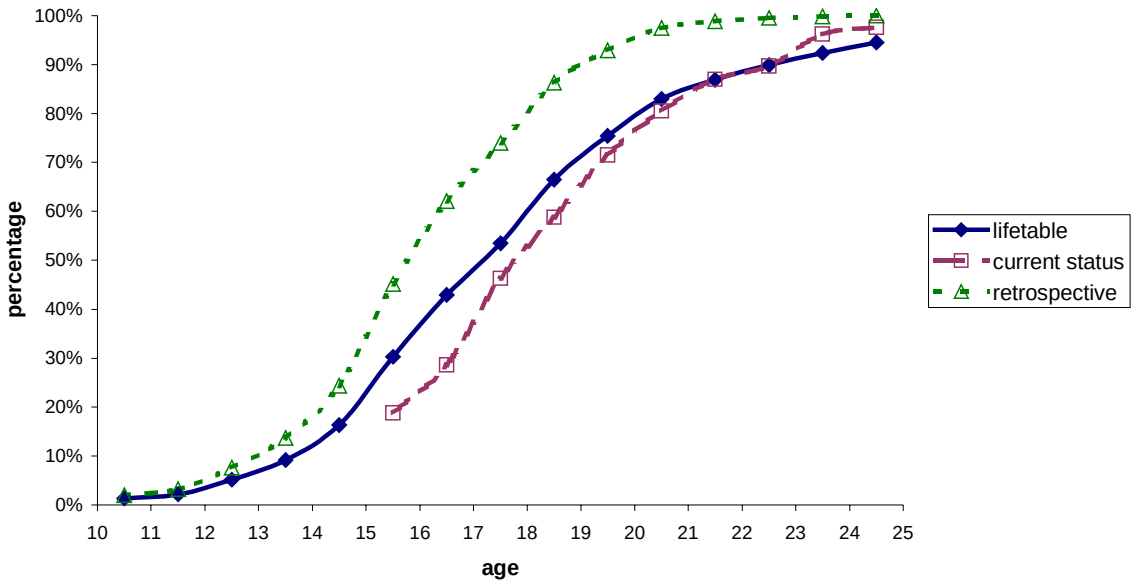
For 15-24 and 15-19 year olds this approach leads to larger values for person-years exposed and smaller sampling errors than simply relying on the current status data only. For 20-24 year olds the life table approach makes less difference compared with using only recalled data if the median age at first sex is well below 20 years of age. But even in those over 20 years the life table approach can yield more robust estimates, if the analysis focuses on subgroups with a relatively late sexual debut.

Several measures can be used to summarize the distribution of age at first sex. The median and interquartile range are possibly the best simple measures that capture the location and shape of the curve. Easily derived alternative measures include e.g. the proportion of adolescents who had ever had sex by age 15 or 18 (making allowance, if necessary for reporting of “age at last birthday” rather than exact age). One or both proportions can be used as summary statistics if median age at first sex or first marriage is beyond the upper age limit of the age group in the analysis. Alternatively, by fitting a model survival distribution to the observed distribution of survival times in the state of virginity, predictions can be made about the location of the median age at first sex, or about proportions sexually active at later ages. Such a procedure is particularly useful when interpreting data from teenage respondents obtained in school surveys, if a significant proportion have not yet experienced sexual intercourse. The gamma distribution has been found to provide a good fit for the observed initiation of first sex

curves (Feeney and Zaba 2001) and can be used to predict the full model distribution and parameters from incomplete observed data.

In terms of trend analysis, linear rank statistical tests can be used to assess the equality in distributions between initiation of first sex curves. The Wilcoxon rank test and the log rank test have been used (Davis and Lay Yee 1999). The log rank test gives more weight to later events than the Wilcoxon rank test, and is more appropriate if meaningful divergence of the survival curves occurs principally at older ages. An additional argument in favor of the log rank test is that it is unlikely that curves describing initiation of first sex correspond to a constant age-specific force. However, for weighted data it is more appropriate to use a Cox-regression based test for equality of survival curves (StataCorp 2001). Figure 1 (based on reports of 1,783 women aged 15-24 in the 1993 Kenya DHS (NCPD, 1994) compares the curves describing cumulative onset of first sex obtained using the life table method with the curves obtained by looking only at current status data and only at recall data for those who have ever had sex. It shows that using recall data alone would give an earlier median age at first sex than an estimate based on the full data set, including those who never had sex. This difference would inevitably be seen, whatever the empirical data source used. Theoretical considerations alone would not necessarily lead us to expect a systematic difference between the current status curve and the survival analysis curve, unless there was an underlying trend in age of sexual debut over time, or if the data were affected by reporting errors. This paper explains how data from successive surveys can be used to discriminate between these two possibilities, and how various life table techniques can be adapted to describe and explain trends in age at first sex and age at first marriage.

Figure 1
Example of different methods to assess age at first sex: Kenya DHS 1993, women aged 15-24, proportion sexually active by age



Data sources

The data sources used for this illustrative analysis were drawn from DHS surveys conducted in six African countries between 1988 and 2000: Ghana (GSS, 1990, 1994, 1999); Kenya (NCPD,

1994, 1989, 1999); Tanzania (Bureau of Statistics 1993,1997, 2000); Uganda (Ministry of Planning and Economic Development, 1989; Statistics Department, 1996, 2002); Zambia (Central Statistical Office 1997, 1993) and Zimbabwe (Central Statistical Office 1989, 1995, 2000). These countries were selected because each had three DHS surveys in this time period, except for Zambia, which conducted DHS surveys in 1992 and 1996, and in 1998 and 2000 held a nationally representative two-round sexual behaviour survey in which the questions about age at first sex were framed in the same way as those used in the DHS (Measure Evaluation, 2001). Data from the two rounds were pooled to provide numbers comparable to DHS surveys. DHS provides dates of birth, first marriage and interview to the nearest month, but age at first sex is truncated to an integer year. To provide smoother transitions in lifetable calculations, a random number generator was used to generate the age at first sex in months and years, assuming a rectangular distribution of events within the year, whilst ensuring that age at first sex did not exceed current age, or age at first marriage. Table 2 gives the survey dates, and the sizes of the male and female populations aged under 25 at the time of the survey, which form the basis of subsequent tables.Most of these countries included males in the two later surveys, though Zimbabwe only included men in the middle survey, and Tanzania included men in all three surveys. The middle survey in Kenya restricted men to those aged 20 and over. Male samples are smaller than female samples, ranging from 20% to 80% of the size of the female sample. Wherever possible, parallel analyses are performed for males and females, but inevitably the scope, strength and significance of the results for males are lower than for females.

Most analyses in this paper deal with the 15-24 age group observed in different surveys, in some cases splitting this group further into teenagers (aged 15-19) and 20-24 year olds. For some analyses, it is useful to examine birth cohorts as they appear in different surveys. The cohorts identified for comparison correspond to those aged 15-19, 20-24 and 25-29 at the last survey, with birth year used to identify the same cohort at different time points.

Table 2
DHS survey years, birth cohorts and population size used for analysis

	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Survey years						
First	1988	1989	1991	1989	1992	1988
Second	1993	1993	1996	1995	1996	1994
Third	1999	1998	1999	2000	1999 [z]	1999
Women 15-24 years						
First	1,716	2,818	4,064	2,142	3,425	1,861
Second	1,632	3,392	3,408	3,162	3,834	2,741
Third	1,810	3,399	1,720	3,119	1,786	2,741
Men 15-24 years						
First			807			
Second	406	525 [k]	859	754	863	1,004
Third	575	1,400	1,330	762	1,278	
Birth cohorts						
Oldest	70-74	69-73	70-74	71-75	70-74	70-74
Middle	75-79	74-78	75-79	76-80	75-79	75-79
Youngest	80-84	79-83	80-84	81-85	80-84	80-84

[z] The third Zambia survey was not a DHS but a two-round sexual behaviour survey, the first round took place in 1998, the second in 2000. Data from the two surveys were pooled for this analysis.
[k] The 1993 Kenya DHS only included males aged 20 and over.

Trend analysis

Table 3 shows how median age at first sex, and the inter-quartile range for age at first sex have changed in the 15-24 age group over the series of three surveys in each of the six countries. The median age at first sex is a general measure of the youthfulness of the start of sexual activity, the inter-quartile range (number of years between the age at which 25% have experienced sexual activity and the age at which 75% are sexually active) tells us how quickly sexual activity builds up among the youthful population once it has been initiated by a substantial minority. Whenever two surveys are compared, the formatting (italics and/or bold face) of the results for the later survey indicates changes that were statistically significant.

Particularly in countries severely affected by the AIDS epidemic, there may have been programme efforts to encourage young people to postpone their sexual debut. If successful, these would have the primary effect of raising the median age, and a secondary effect of widening the inter-quartile range. Such campaigns may also induce young people to under-report the extent of their sexual activity, either by denying that they are sexually active, or by mis-reporting the age at which they first had sex.

Table 3
Median age at first sex (with interquartile range), by sex, country and survey, for respondents aged 15-24 at survey.

Survey	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men						
first			16.2 (4.0)			
second	18.4 (3.9)	16.2 (3.5)	**17.8 (3.9)**	17.5 (3.8)	15.8 (4.5)	18.6 (3.8)
third	**19.7 (5.2)**	*16.4 (4.5)*	**17.0 (3.5)**	***18.1 (4.1)***	16.3 (3.3)	
Women						
first	16.8 (2.9)	16.9 (3.6)	17.1 (3.2)	15.9 (3.1)	16.4 (3.1)	18.4 (4.5)
second	16.8 (3.0)	**17.3 (4.1)**	17.1 (3.5)	16.2 (3.3)	16.4 (3.2)	*18.6 (4.3)*
third	**17.6 (3.4)**	17.3 (3.9)	***16.9 (3.1)***	**16.7 (3.1)**	**16.4 (2.5)**	18.4 (3.8)

Significance of difference with previous survey from Cox-regression based test for equality of survival curves: **bold < 0.2%, *bold italic < 1.0%,*** *italic < 5.0%*

There is a wide diversity of patterns, trends and sex differentials in age at first sex in these six countries. Median age at first sex ranges from 16.2 to 18.6 for females, 15.8 to 18.6 for males, the inter-quartile range varies from 2.9 to 4.5 years for females, 3.3 to 5.2 years for males. Sex differentials are not uniform, with males having an older age at first sex and slower progression than females in Ghana and Uganda, with the reverse for Kenya. Historically, Uganda reported the lowest female age at first sex, but in recent times Zambian women have reported the lower ages. Females in Zimbabwe report the latest starting ages for sexual activity, and the slowest progression.

In general, there is a tendency over time for both sexes to report later sexual debut, and for sexual activity amongst adolescents to spread more slowly, once initiated by a substantial minority. However, Tanzanian females are an exception to this general trend, reporting a younger start to sexual activity and faster progression in recent years. More significant changes occured in the second inter-survey interval than in the first.

One problem with the analysis in Table 3 is that inclusion of respondents over 20 years makes the picture presented less current. Recall data for the older informants (20-24 year-olds) provide information on age at first sex a number of years before the survey. If most 20-24 year

olds report their age at first sex was at 17 years, then their first sexual experience occurred on average 3 to 7 years before the time of the survey. More recent data on trends are often required for program planning and evaluation purposes, especially in the context of the AIDS epidemic. Furthermore, if the surveys are five years (or less) apart, there is a substantial overlap in age cohorts which obscures true trends among teenagers. For this reason it is useful to look separately at trends based on respondents under 20 (Table 4).

An examination of differences between age groups within each survey shows that in Kenya and Uganda 15-19 year-old females report a later age at first sex than those aged 20-24 at each survey, suggesting a rise in age at sexual debut over time. For Tanzanian females the opposite is true – these implied trends are consistent with between survey changes noted in Table 3. The magnitude of differences between age groups tends to be larger than the between survey changes noted previously: differences of more than half a year in median age are seen for females in Ghana, Kenya, Uganda, Zambia and Zimbabwe. In Kenya, and Uganda the between age group differences attain statistical significance at each survey.

Table 4
Median age at first sex, by sex, age group, country and survey

Survey	Age group	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men							
First	15-19			16.2			
	20-24			16.1			
Second	15-19	18.5	na	17.9	17.7	15.8	18.5
	20-24	18.3	16.2	17.8	17.3	15.9	18.5
Third	15-19	over 20	16.5	16.6	18.3	15.8	
	20-24	***19.3***	16.0	***17.4***	18.2	**17.0**	
Women							
First	15-19	17.0	17.5	17.2	16.0	16.5	18.9
	20-24	**16.6**	**16.5**	*17.0*	**15.8**	16.4	**18.1**
Second	15-19	16.8	17.7	17.3	16.3	16.6	18.8
	20-24	16.8	**17.0**	**17.0**	**16.1**	*16.3*	**18.4**
Third	15-19	18.1	17.6	17.0	17.1	16.1	18.6
	20-24	**17.3**	**17.1**	16.7	**16.3**	**16.8**	18.4

Significance of difference with previous age group from Cox-regression based test for equality of survival curves:
bold < 0.2%, *bold italic < 1.0%,* *italic < 5.0%*

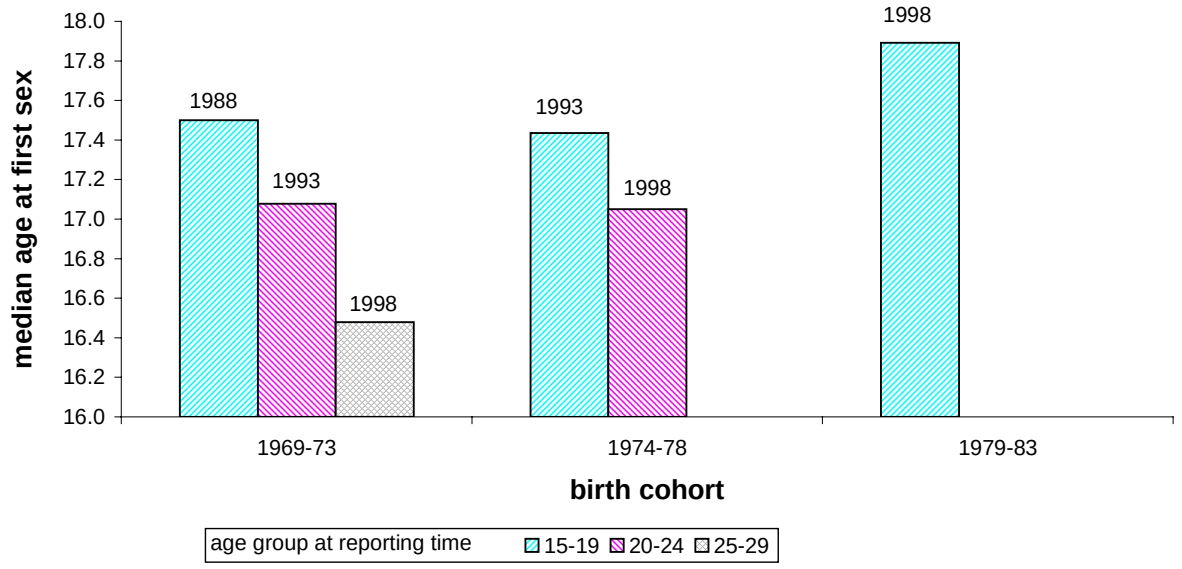
Since surveys are generally 4 to 6 years apart, the 15-19 age group in an earlier survey should correspond approximately to the 20-24 age group in the following one. Unlike the mean, which is influenced by later events, the median age at first sex should not change as a cohort ages from one survey to the next. However, many contradictions are apparent, with some female cohorts in Kenya and Tanzania and male cohorts in Ghana, Tanzania and Zambia showing unexpectedly large variation in median age at first sex between surveys. To examine this problem more closely, in Table 5 we present the median age at first sex in cohorts classified by exact year of birth.

Table 5
Median age at first sex by country, cohort, sex and age at survey (pooled data)

Cohort	age at survey	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men							
Oldest	15-19			16.4			
	20-24	18.3	16.2	17.0	17.4	15.8	19.4
	25-29	19.1	16.2	17.6	17.9	16.1	18.6
Middle	15-19	18.6	16.0	17.1	17.8	15.5	18.5
	20-24	19.3	16.1	17.3	18.2	16.0	
Youngest	15-19		16.7	16.8	18.4	16.1	
Women							
Oldest	15-19	17.1	17.5	17.2	16.3	16.3	19.0
	20-24	16.8	17.1	17.0	16.0	16.4	18.3
	25-29	17.5	16.5	16.6	16.4	16.2	18.5
Middle	15-19	16.8	17.4	17.3	16.3	16.5	18.8
	20-24	17.3	17.0	16.9	16.3	16.3	18.4
Youngest	15-19	18.1	17.9	17.1	17.1	17.0	18.6

Although the overall trends between birth cohorts replicate the trends over time evident in Table 3, where a cohort is captured at different reporting ages in two or more surveys various inconsistencies are apparent. In general, male cohorts report an older age at first sex when questioned at later ages, whereas females tend to report younger age at first sex when their cohort is surveyed at later ages. The exceptions to this general observation are Kenyan males and Ugandan females – these cohorts gave consistent reports regardless of the age at which they were approached; and Zimbabwean men and Ghanian women, who display a reporting bias in the opposite direction to that which is typical of their sex.

Figure 2 Within cohort inconsistency in median age at first sex:
(a) Tanzanian males



(b) Kenya females

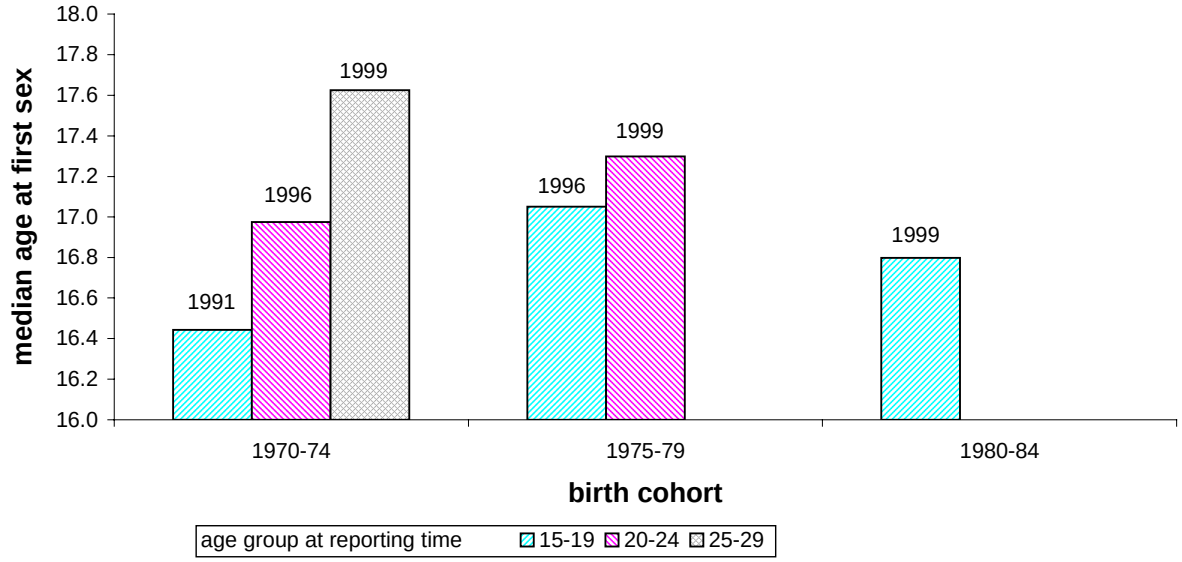


Figure 2 illustrates the magnitude of these errors in Tanzanian males and Kenyan females – we would expect the medians for any one cohort to be the same, regardless of survey and reporting age. The fact that different patterns are observed for different countries suggests a variety of reporting errors may occur, with different prominence in the different populations.

If people misreport their early sexual experience in the light of campaigns promoting abstinence for youth in the face of the HIV epidemic, we would expect two types of reporting error. Among younger respondents there may be a denial of sexual activity by some of those who are not in fact virgins. This would lead to the reported median age at first sex falling as the cohort aged, assuming less denial of sexual activity among older respondents, many of whom would be married and would no longer need to deny that they were sexually active. This could give rise to the reporting pattern that is more typically seen in female cohorts in our data set. The second type of reporting error would occur if older respondents had a tendency to report that first sex had occurred at a later age than it had in fact. This might tend to happen particularly if the first sexual encounter was with someone other than their spouse. This type of misreporting would tend to produce the cohort reporting pattern more typical of males.

A different type of reporting error may occur among males in spite of campaigns promoting sexual abstinence among adolescents: if male teenage virgins felt the need to claim that they were already sexually experienced this would lower the median age at first sex computed for the cohort at young reporting ages. Real differences in the median age at first sex reported by cohorts at different ages could arise if age at sexual debut was highly correlated with mortality or migration. If HIV-related mortality starts to deplete cohorts before they reach their mid-twenties, we would observe an increase in median age at first sex as the cohorts aged, because those who became sexually active at the youngest ages would also face the risk of HIV infection earlier, and thus an earlier chance of developing AIDS.

Finally, within cohort inconsistencies could also arise as a result of selection effects if samples drawn in consecutive surveys fail to reach their aim of being nationally representative at all ages. For example, if age at first sex is strongly correlated with education, or place of residence, and one survey happens to under- or over-represent respondents with secondary education or urban residence, a spurious difference by survey (and thus by reporting age) would be produced within birth cohorts observed in that survey.

Table 6 shows the scale of the differentials associated with education and residence in the population aged under 25, using data pooled from all three surveys. Table 7 shows the changes in the education and residence composition of the three cohorts. Note that real changes over time in education levels or residence patterns would not produce the within birth cohort discrepancies shown above, but the changes over time may be partly real, and partly a result of an imperfect sampling strategy.

These tables show that secondary education and urban residence are generally associated with later age at first sex for both males and females, and that in addition, progression of start of sexual activity is slower among more educated females. Differentials are generally larger and statistically more significant for females than males. Education differentials are more consistent, larger and statistically stronger than those associated with residence – indeed they are considerably larger than the changes over time shown in Table 3.

The proportion of male respondents with secondary education has declined from oldest to youngest birth cohorts in all countries, but increased for females in Uganda and Zimbabwe. A breakdown by reporting age (not shown) suggests some exaggeration of educational attainment by older respondents – changes in educational attainment may be expected due to secondary school enrollment between ages 15-19 and 20-24, but not between 20-24 and 25-29. There is a markedly higher proportion urban among the older male cohorts in Ghana, Kenya and Zimbabwe, and in older females in Kenya, suggesting a rural to urban migration flow that accelerates in the late teens and early twenties. In itself, such a migration flow should not

cause within birth cohort discrepancies in reporting age at first sex, unless there was a tendency to under-sample the mobile population in some surveys.

Table 6: Median age at first sex (inter-quartile range) among 15-24 year olds, by sex, country, and education or residence (pooled survey data).

	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men						
Primary or less	19.0 (4.5)	16.4 (4.4)	16.9 (3.6)	17.8 (3.8)	15.9 (4.1)	18.3 (3.3)
Secondary or higher	19.8 (5.5)	*16.3 (3.8)*	**17.7 (3.7)**	18.0 (4.3)	**16.3 (3.8)**	18.7 (3.8)
Women						
Primary or less	16.9 (3.0)	16.7 (3.4)	17.0 (3.1)	16.1 (3.0)	16.1 (2.6)	17.2 (3.2)
Secondary or higher	**18.4 (3.8)**	**18.6 (4.3)**	**19.3 (4.2)**	**17.7 (3.7)**	**17.6 (3.7)**	**19.4 (4.1)**
Men						
Rural	18.9 (4.8)	16.3 (4.3)	17.1 (3.6)	18.0 (4.0)	15.9 (4.2)	18.5 (3.5)
Urban	19.9 (4.3)	***16.5 (3.9)***	16.8 (3.5)	**17.2 (3.5)**	**16.3 (3.8)**	18.7 (4.0)
Women						
Rural	16.8 (2.9)	17.2 (3.9)	17.0 (3.3)	16.3 (3.2)	16.2 (2.7)	18.2 (3.7)
Urban	**17.6 (3.3)**	**17.3 (4.0)**	**17.3 (3.2)**	**16.6 (3.3)**	**16.8 (3.4)**	**19.3 (4.6)**

Significance of difference with previous category from Cox-regression based test for equality of survival curves: **bold < 0.2%, *bold italic < 1.0%,*** *italic < 5.0%*

Table 7
Percentage with secondary education and urban residence by sex and birth cohort

	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Secondary education						
Men						
Oldest	26.5	47.6	9.6	32.2	50.2	77.4
Middle	20.7	44.1	7.4	29.1	47.0	60.9
Youngest	13.7	25.5	4.1	26.4	32.4	
Women						
Oldest	9.6	31.0	7.8	16.7	30.4	58.3
Middle	13.4	27.2	6.6	18.9	30.4	61.9
Youngest	8.2	22.1	3.7	24.9	30.4	68.1
Urban residence						
Men						
Oldest	38.8	29.0	29.8	19.2	43.5	41.4
Middle	36.4	28.6	25.5	16.7	41.4	22.7
Youngest	31.7	15.4	24.2	18.5	40.7	
Women						
Oldest	38.1	23.2	28.1	15.7	48.1	37.6
Middle	41.5	22.4	27.9	18.3	49.0	37.4
Youngest	37.2	20.4	21.2	19.4	45.4	35.2

We can asses the scale of the bias due to reporting age, as well as the effects of changes in education and residence, both real (due to changes in composition of the population over time) and spurious (due to imperfect sampling), on the reported median age at first sex, by constructing virginity life tables for birth cohorts adjusted for education, residence and reporting

age. The results of this procedure are shown in Table 8. The top panel for each sex shows the difference in median age at first sex for successive cohorts using pooled data from all available surveys, the middle panel shows the same differences after adjustment for the structural and selection effects of education and residence, the bottom panel includes an additional adjustment for age at survey (reporting error associated with age). Positive differences imply age at first sex becoming older over time. There are not enough data for males in all birth cohorts in Ghana and in Zimbabwe to allow for a complete analysis.

In general, adjustment results in a loss of significance in the apparent cohort trends for males, except for the case of Uganda and Tanzania, where there is a larger and more significant increase in age at first sex between the older two cohorts after adjusting for reporting age, education and residence. In the case of females, trends in Ghana, Uganda and Zambia retain their significance after adjustment, the main increase occuring between the two younger cohorts. The Kenyan female inter-cohort differences lose significance after adjusting for reporting age.

Table 8
Adjustment of cohort differences in median age at first sex to allow for changes in education, residence and reporting age (pooled survey data)

Men	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Unadjusted						
middle – oldest		-0.1	0.2	0.3	-0.1	
youngest – middle		*0.5*	-0.4	0.6	0.2	
Adjusted for education and residence						
middle – oldest		-0.1	0.1	0.5	-0.1	
youngest – middle		*0.5*	-0.3	0.2	0.2	
Adjusted for reporting age, education and residence						
middle – oldest		-0.1	*0.3*	*0.7*	0.0	
Youngest - middle		0.5	-0.1	0.3	0.3	
Women						
Unadjusted						
middle – oldest	-0.1	***0.2***	***0.2***	0.1	0.1	*0.2*
youngest – middle	**1.0**	**0.5**	0.0	**0.8**	**0.6**	0.0
Adjusted for education and residence						
middle – oldest	-0.2	**0.3**	**0.2**	0.1	0.1	0.2
youngest – middle	**1.1**	**0.5**	0.0	**0.7**	**0.5**	0.0
Adjusted for reporting age, education and residence						
middle - oldest	0.0	0.2	0.1	0.1	0.1	0.0
youngest - middle	**1.3**	*0.4*	-0.1	**0.7**	**0.5**	-0.2

Significance of difference between cohorts from Cox-regression based test for equality of survival curves: **bold < 0.2%, *bold italic < 1.0%,*** *italic < 5.0%*

Simply initiating sex does not put someone at risk of STI – infection risks only arise if sex occurs with partners who have had other partners. In general, premarital and extramarital partners are more likely to be non-monogamous than spouses. Table 9 examines premarital sexual activity.

Between 27% and 81% of never married males under age 25 are sexually active, as are 10% to 28% of unmarried females, with Zambia and Kenya showing the most extreme differences between the sexes. Overall, Uganda and Zimbabwe have low rates of sexual activity among the never married, Kenya and Zambia have relatively high rates.

Table 9
Percentage of never married aged 15-24 who are sexually active, by sex and survey

Survey	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men						
First			57.8			
Second	43.6	72.7	46.4	35.0	61.8	42.5
Third	27.3	59.7	54.4	36.4	82.8	
Women						
First	22.1	25.6	20.1	17.3	25.0	13.1
Second	28.4	27.6	20.1	10.4	24.2	10.1
Third	21.1	25.5	21.2	15.8	52.7	11.0

However, this measure of "unsafe" sexual activity is also problematic, as it does not allow for the effects of age structure in the under 25 age group. By constructing life tables for first sex and for first marriage and then comparing the median ages we can get over this problem. The differences between the medians at each survey are shown in table 10, though for males the data are incomplete, as in many cases the median age at marriage for males is over 25. Broadly, the findings of Table 9 are confirmed, with males having longer gaps between median age at first sex and median age at marriage than females. Uganda and Zimbabwe have relatively short gaps, Kenya and Zambia relatively long ones.

Table 10
Difference in median ages at marriage and first sex, by survey

Survey	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men						
First			*na*			
Second	*na*	*na*	6.4	4.5	*na*	*na*
Third	*na*	*na*	6.8	4.7	7.6	
Women						
First	2.2	3.1	2.0	1.9	2.4	1.6
Second	2.5	3.6	2.1	1.4	2.3	1.4
Third	2.4	3.3	2.1	1.4	3.6	1.2

na median age at first marriage for men is higher than 25

However, even this measure is difficult to interpret, as trends can be the result of changes in age at first sex or changes in age at first marriage. Furthermore, it does not distinguish between those who entered sexual activity as a direct result of getting married, and those who became sexually active before marriage. For a given difference in median ages, the higher the proportion of persons marrying as virgins, the longer the average duration between becoming sexually active and marriage for those who experience pre-marital sex.

To allow both for age structure effects and for the different paths that young people can follow to sexual activity and marriage, instead of simple two-state life tables (virgins / sexually active;

single / married) we can construct a multi-state life table, allowing for virginity, sexual activity by those who are not married, and for entry into marriage from both of these states. Table 11 shows the person-years spent in these states by the two youngest 10-year birth cohorts for each country: those aged 25-34 and those aged under 25 at the last survey. The age range covered by the multi-state life table is 15 to 25, so that the person-years sum to 10 in each case, mortality is not allowed for. Ten year cohorts are used because proportions married by age 20, particularly for males, are too low to reveal all the interesting differences.

Table 11
Person-years lived between 15 and 25 by sexual activity status in the birth cohorts aged 25-34 and 15-24 at the last survey, by sex and country

Status	Ghana	Kenya	Tanzania	Uganda	Zambia	Zimbabwe
Men, older cohort						
Virgin	4.0	2.1	2.8	3.0	2.2	3.8
Sexually active only after marriage	0.6	0.1	0.4	1.1	0.2	0.4
Married after premarital sex	1.3	1.1	1.8	2.3	2.1	1.1
Not married and sexually active	4.2	6.6	5.0	3.6	5.5	4.7
Men, younger cohort						
Virgin	5.1	2.4	2.8	3.4	2.2	
Sexually active only after marriage	0.4	0.4	0.3	0.8	0.1	
Married after premarital sex	1.1	0.7	1.7	2.1	1.4	
Not married and sexually active	3.4	6.4	5.2	3.7	6.4	
Women, older cohort						
Virgin	2.7	2.8	2.5	1.9	2.1	3.9
Sexually active only after marriage	2.4	0.9	2.3	2.6	2.2	2.2
Married after premarital sex	2.8	3.6	3.3	4.0	3.6	2.8
Not married and sexually active	2.2	2.8	2.0	1.5	2.1	1.2
Women, younger cohort						
Virgin	2.9	3.2	2.7	2.2	2.2	4.1
Sexually active only after marriage	2.0	0.4	2.0	2.7	1.8	2.1
Married after premarital sex	2.6	3.7	3.3	3.6	3.5	2.7
Not married and sexually active	2.5	2.7	2.0	1.5	2.5	1.0

Males spend much longer than females in the sexually active unmarried state in all countries. Larger proportions of women than men claim not to have been sexually active before marriage, so that females who have not had a previous sexual partner contribute many more person-years of marriage in this risk group than do men. This implies that women would be exposed to higher risks of aquiring a sexually transmitted infection from their husbands than vice-versa even if after marriage neither partner had extra-marital sex.

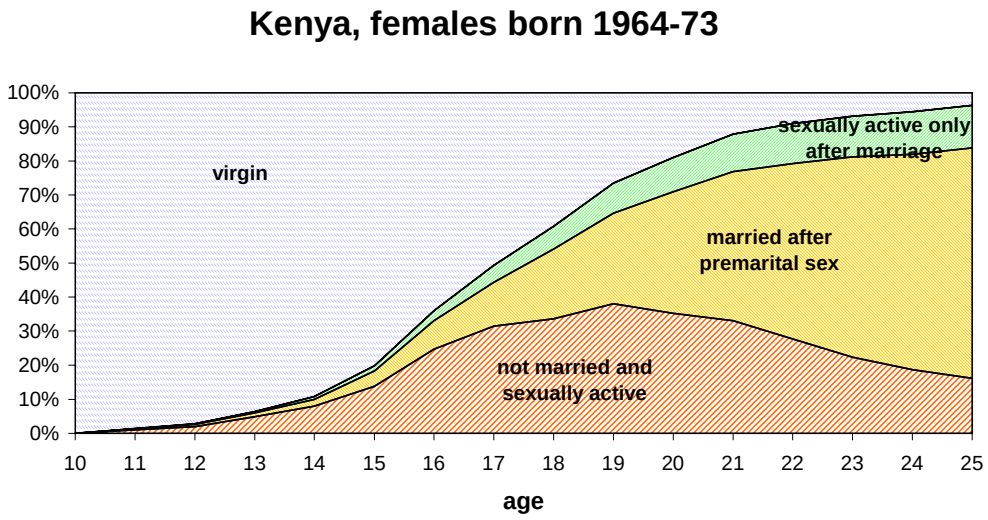
Uganda and Zimbabwe have the highest proportions of women marrying as virgins, Kenya has the lowest. Zambia and Kenya have very large differences between the sexes with respect to pre-marital sex, in Ghana the experience of males and females is fairly similar. High levels of sexual activity among unmarried people are seen in Kenya and Zambia, with relatively low levels reported in Uganda and Zimbabwe. Uganda has much higher person-years married (combining those who marry as virgins with those who are sexually experienced) than any other country, Kenya has the lowest (for both males and females).

The major inter-cohort changes for males are a large increase in virginity in Ghana, with a consequent lowering of pre-marital sexual activity; and an increase in pre-marital sexual activity in Zambia as a result of declines in transition from pre-marital sexual activity to marriage. Changes for females have been less dramatic – a general increase in virginity, most notably in Kenya and Uganda, and a decline in marriage among virgins in Ghana and Zambia, leading to increases in pre-marital sexual activity.

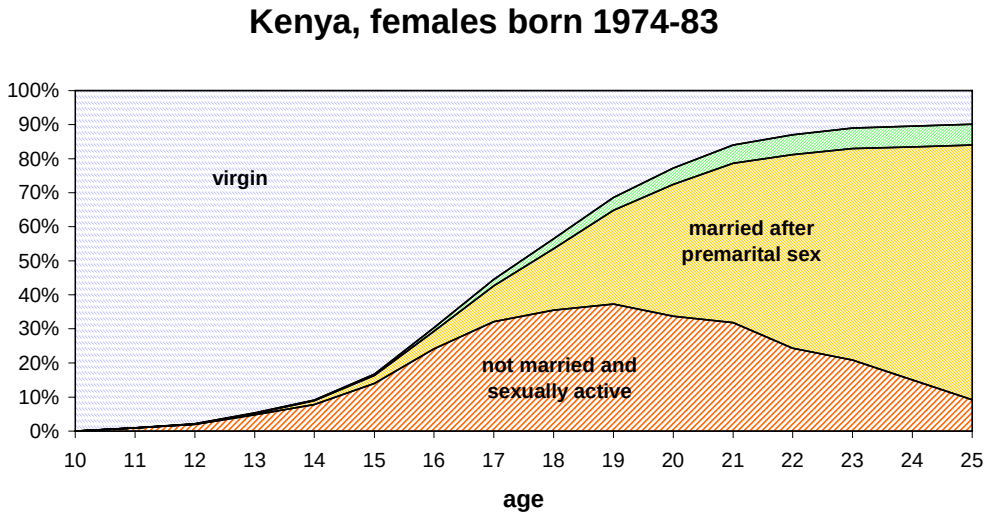
The striking inter-country and male – female differences in this multi-state analysis are illustrated in figure 3, a series of stacked area graphs comparing the proportion of each year lived by the lifetable population that is spent in each of these states. The countries compared are Uganda and Kenya, and the first graph in each series shows the experience of women aged 25-34 at the time of the last survey, the next two graphs illustrate the experience of women and men aged 15-24 at that time.

Figure 3
Percent of life table person-years by sexual activity and marital status

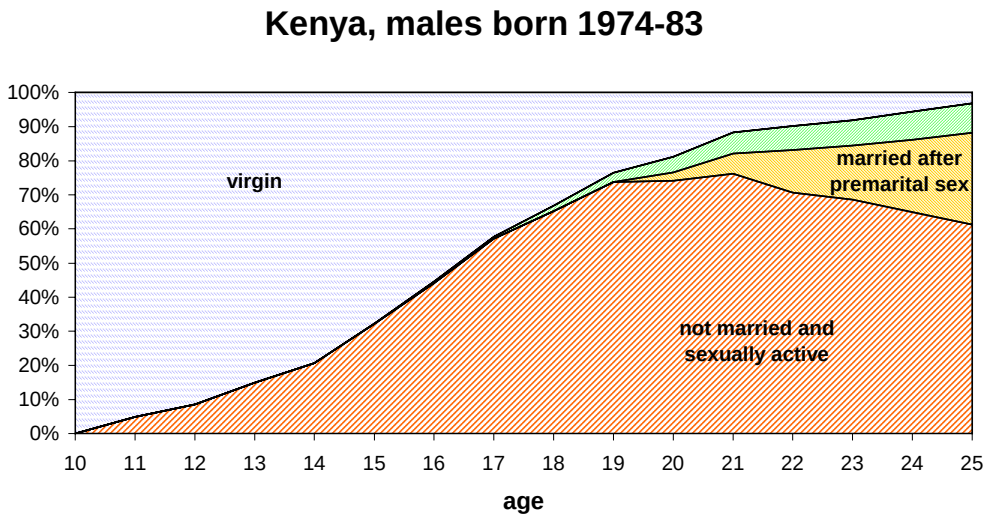
(a)



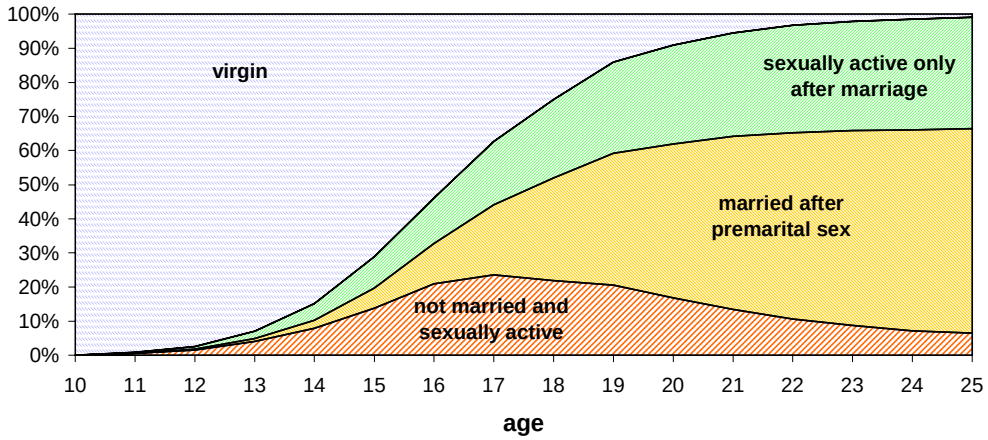
(b)



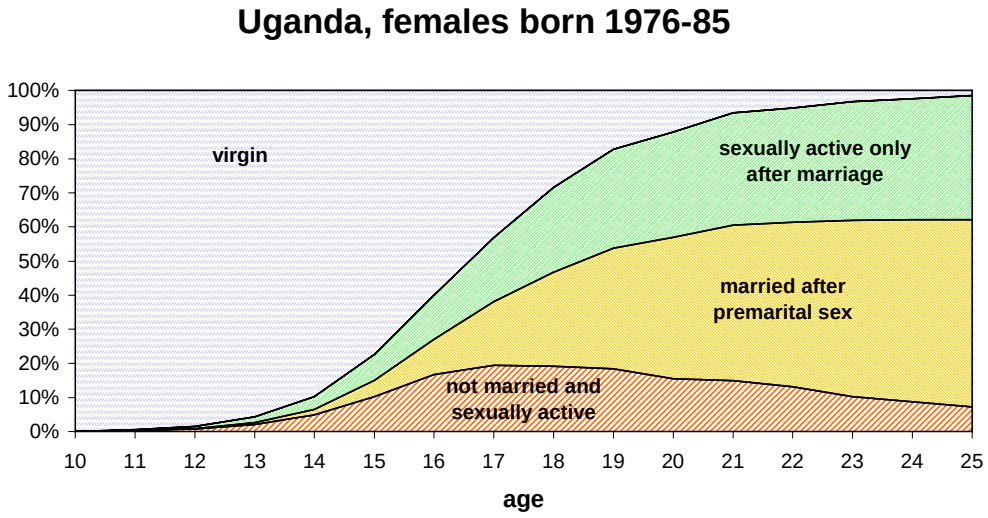
(c)


Kenya, males born 1974-83
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
virgin
married after premarital sex
not married and sexually active
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
age

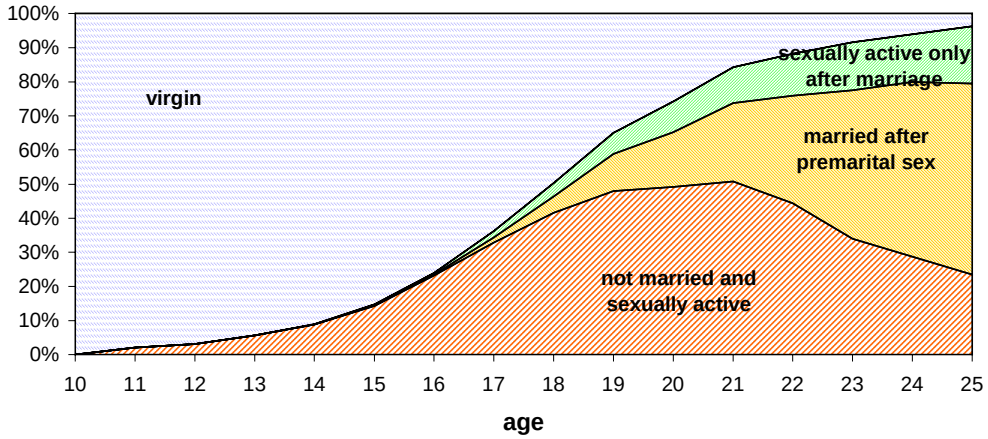
(d)


Uganda, females born 1966-75
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
virgin
sexually active only after marriage
married after premarital sex
not married and sexually active
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
age

(e)



(f)



These diagrams show both the timing of the various transitions and the overall scale of "unsafe" pre-marital sexual activity in these populations. From the graphs it is clear that there is a bigger contrast between these two countries in what happens after the start of sexual activity than in its timing. As seen in table 3, sexual initiation actually occurs earlier among Ugandan women than among their counterparts in Kenya, but a higher proportion of this occurs as a result of early marriage. Among both men and women who experience sex before marriage in Uganda there is a fairly rapid transition to marriage, whereas in Kenya the period of pre-marital sexual activity is much longer, and involves a higher proportion of the cohort. There is a much more dramatic contrast between the experience of the sexes and between the two countries than between successive ten-year cohorts.

Conclusion

This analysis set out with a methodological and a substantive objective. Previous analyses of survey data on age at first sex have not made full use of the available data. The use of survival

analysis based on current status and recall data enhances sample size and provides more robust estimates of age at first sex. When multiple cross-sectional surveys over time are available for the same population, analysis by birth cohort gives further insights into trends in age at first sex and also into the effects of changes in the composition of the sample between surveys and into possible reporting biases as well. The cohort approach showed that in several countries with multiple surveys changes in reporting bias had occurred over time and consequently affected trend analyses. Finally, a multi-state life table is the most complete method to capture patterns of sexual initiation in relation to marriage.

Substantively, the key issue was to examine whether Uganda's trends in adolescent sexual activity were different from those of other countries. Uganda was the only country in sub-Saharan Africa with a significant decline in HIV prevalence during the nineties. Table 8 indeed showed that large increases in age at first sex had occurred in Uganda for both males and females. These statistically significant increases occurred during both the early and late nineties, although the trends found in the DHS analysis were not as large as those reported in a study of two urban areas in Uganda (Asiimwe Okiror et al. 1997). Ghana and Zambia also recorded significant positive trends among women. The changes in Uganda happened against a historical background of very early sexual initiation, largely a result of early marriage, and Uganda has maintained a very rapid transition from sexual activity to marriage, unlike Zambia, where a later start to sexual activity was accompanied by a lengthening of the time spent sexually active but unmarried. It is noted that the third survey in Zambia was not a regular DHS but was based on pooled data from two national sexual behaviour surveys in 1998 and 2000. Even though the questions on sexual behaviour were very similar to a DHS, the different length of the questionnaire and context may have affected comparability.

The quality of self-reported data on initiation of sex was only partly examined in this paper, focusing on changes in bias over time. Previous analyses of DHS data indicate that survey-based aggregate measures of age at first sexual intercourse produce valid results (Blanc and Rutenberg 1991), though some systematic errors in reporting of first sex have been suggested (Meekers 1995). In Zimbabwe men and women consistently report a later initiation of sex than respondents in the other five countries, but this may be due in part to reporting bias caused by a denial of any kind of sexual activity by teenagers. The relatively limited exposure to pre-marital sex reported by adolescents in Zimbabwe is also somewhat surprising in the context of the very high and rapidly rising level of HIV found in that country at the end of the nineties (UNAIDS, 2001).

For evaluating interventions, changes in biases over time are the prime concern. If HIV prevention programmes strongly promote postponement of first sex, it may become progressively less desirable for a teenager to report sexual activity. This may be particularly significant if the teenager is still in school, as strong sanctions may exist against sexual activity during the school years. Age misstatement is a problem if the respondent does not know his or her exact age, although this problem is likely to be less severe among adolescents and people in their early twenties than among the older population. There may however be deliberate misreporting of age under the influence of interventions. Teenagers who have initiated sex and report so may tend to over-report their current age – if this includes shifts from one 5-year age group to the next it may also make it difficult to trace true cohorts between surveys.

It is important to standardize for the educational composition of the cohorts being compared. Secondary education is a powerful determinant of age at first sex, and if there are changes in the proportions enrolled in secondary school it is useful to separate out the effects of such changes from overall secular changes affecting girls within each educational subgroup. The

cohort-based analysis of the Kenyan data alerted us to the possibility of other biases that may compound the under-reporting of sexual activity by teenagers. The data show that within cohorts there are changes in the educational composition of the population going from one survey to the next – e.g. the cohort born in 1969-73 recorded an increase in proportion with secondary education from 23% in 1988 when they were aged 15-19 to 33% in 1993 when they were 20-24. Similarly the cohort born 1974-78 recorded an increase in proportion with secondary education from 19% to 35% as they progressed from 15-19 in 1993 to 1998. Several factors may account for this: entry into secondary school after age 15; sampling errors that have produced increasingly educated samples; and selection effects whereby boarding school pupils (a significant fraction of secondary school children) are excluded from household based samples.

The within cohort comparisons, (Figure 2 and Table 5) and the statistical adjustment for education, residence and reporting age (Table 8) have alerted us to the wide range of biases that can affect a simple comparison of age at first sex from cross sectional surveys. A comparison of median age at first sex in successive age groups, or in succeeding surveys can make it appear that adolescent sexual behaviour is changing when the differences are actually due to reporting errors or sampling problems. This paper has suggested a variety of ways for identifying and allowing for these biases, and has shown that in the case of Uganda, the positive findings stand up to critical scrutiny. Our proposed extension of the life table approach to quantifying the contribution of pre-marital sexual activity to sexual risk exposure in adolescence also highlighted the potential importance of rapid transition to marriage as a possible protective factor in that country.

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